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American Caudata. II. Geographic Variation in *Ambystoma macrodactylum*

By M. B. MITTLEMAN

In a brief but important paper on North American salamanders, Baird described *Ambystoma macrodactyla* (1849: 292) on the basis of a small series of specimens "Brought from Astoria, Oregon, by J. K. Townsend, M. D." Since the original description is not easily available, I quote it in full:

> AMBYSTOMA MACRODACTYLA, *BAIRD.* Scull [sic] longer than broad. Toes long, unwebbed. A broad dorsal reddish brown stripe. Beneath dark brown, unspotted.
>
> Body rather more slender than in the other species of *Ambystoma*; the proportions nearly those of *Desmognathus fuscus* (Raf.). The colors somewhat like those of a badly preserved *Plethodon erythronotus* (Green). Ground color dark brown. A broad dorsal stripe, originally, it is probable, of a chestnut brown color, now very obscure. Sides sprinkled with grayish. The brown of the sides becomes more concentrated towards the vertebral line. Tail sub-round, not compressed. Largest specimen about 2¾ inches. From the snout to the insertion of the hind legs 1½ inches.

Baird's species was immediately recognized and accepted, and its subsequent history has been characterized primarily by the gradual discovery of its range and natural history, rather than by nomenclatorial disputes. However, three nominal species of salamanders have been described which are today considered synonyms of *macrodactylum*. Thus, Peters described *Amblystoma krausei* from the Flathead River, Montana (1882: 145), which received little or no notice until Cope (1889: 96-97) declared it to be synonymous with *macrodactylum*. Cope had described *Ambystoma epixanthum* (1883: 16) from the South Boise River, Idaho, and although he failed to recognize *krausei* in 1889 (*loc. cit.*), he reiterated then his earlier statement (1883: 16) that "the structural differences between . . . [*A. epixanthum*] . . . and the *A. macrodactylum* are not many, but are well marked." Cope's reluctance to accept Peters' species, while yet insisting on the validity of his own seems difficult to explain on any grounds but sheer contentiousness. The synonymy of *macrodactylum* is completed with the inclusion of Ruthven's *Ambystoma stejnegeri* (1912: 517) described from a small series of specimens taken at Bloomfield,

Davis Co., Iowa.

As currently known, *macrodactylum* ranges from Calaveras, Alpine, and Eldorado counties, California, north through Oregon and Washington to about latitude 58° in British Columbia, and east to Alberta (Banff and Jasper), Idaho, Montana (Ft. Custer and Glacier National Park), and Iowa (Bloomfield).

A study of 389 specimens of *macrodactylum* (including one of Baird's cotypes, the cotypes of *epixanthum*, and the type and a cotype of *stejnegeri*) shows that this species is composed of two allopatric races. One form, *A. macrodactylum macrodactylum* Baird, ranges from the Columbia Plateaus province and the northern Basin and Range province in Washington and Oregon, through the Cascade-Sierra province and Pacific Border province from Calaveras County, California to southeastern British Columbia. The other race, *A. macrodactylum krausei* Peters, is known definitely from the Northern Rocky Mountains province in Idaho and Montana, and from southwestern Alberta and British Columbia as far west as Kamloops, and probably north to Lat. 58°; it has been recorded also from Iowa.

The races *macrodactylum* and *krausei* are separable on the basis of three quantitative criteria (total vomerine count, ratio of head width to snout-vent length, ratio of head width to head length), and certain color differences. Each of these will be discussed separately.

VOMERINE COUNTS

The vomerine teeth in *Ambystoma macrodactylum* are dispersed in four series: two median series lying posterior to the nares on either side of the midline, and another short series lying lateral of the median series on either side. In some specimens, the two median series are continuous, and rarely, all four series may be fused to form a single recurved line of teeth extending across the anterior part of the roof of the mouth. Considerable variation is found in the number of teeth per series. Thus, while Bishop (1943: 142) reports 9-10 teeth in the median series, and 3-5 teeth in the lateral series, I find that the median rows vary from 7 to 16 teeth per series, and the lateral series have from 2 to 10 teeth. As will be shown, despite considerable latitude, there is a significant degree of association between vomerine teeth counts and geographic origin.

In the course of the statistical analyses made in connection with the present study it was found that if the combined vomerine count (i.e., the aggregate count of all four series) was used as the comparative criterion, rather than the counts of the individual disjunct series, a clearer and simpler picture of the quantitative differences between populations was obtainable. Accordingly, in the discussion which follows, all vomerine counts are combined (aggregate) counts of all four series of teeth in each specimen.

Ontogenetic Variation

Internal examination of large series of specimens indicates that sexual maturity is attained at a snout-vent length of 38 mm. in males, and about 39 mm. in females. In very young (newly metamorphosed) specimens, the vomerine series are poorly developed, greatly reduced in number, and occasionally indiscernible. By the time the animal has attained a snout-vent length of 29-31 mm., the teeth are well developed in size and number.

In a series of 45 specimens varying from 31 to 59 mm. snout-vent length, from McCall and Payette Lake, Valley County, Idaho, the extreme range of the vomerine count is 22-36. The variation in the vomerine counts, according to snout-vent length, may be seen in Table 1:

Snout-vent Length	Range of Vomerine Counts	N
31	24	1
39	28	1
41	32	1
43	33	1
44	30	1
46	25-33	2
49	35	1
50	23-32	2
51	31-36	2
52	27-34	4
53	23-36	6
54	29-34	6
55	22-35	6
56	23-35	6
57	31-33	3
59	26-29	2
		45

Table 1. Variation in combined vomerine counts by snout-vent length in 45 specimens of *Ambystoma macrodactylum* from McCall and Payette Lake, Valley Co., Idaho.

It will be observed that the vomerine count increases with size in the first four specimens (31-43 mm.), from 24 to 33, but that there is a complete overlap in the counts of the succeeding 41 specimens. A very minor degree of association between size and vomerine count is detectable if this series is divided into two groups, one consisting of specimens from 31 to 50 mm. snout-vent length, the other composed of specimens ranging from 51 to 59 mm. in length, as shown in Table 2:

Snout-vent Length	Range of Vomerine Counts		N
	22-30	31-36	
31-50 mm.	5	5	10
51-59 mm.	13	22	35

Table 2. Association of combined vomerine counts and snout-vent length in 45 specimens of *Ambystoma macrodactyla* from McCall and Payette Lake, Valley Co., Idaho.

Application of the chi-square test of association to the data in Table 2 results in a value of 0.5, indicating that so far as this sample goes, the association between the vomerine count and snout-vent length is for practical purposes nil. However, since examination of very young specimens reveals a greatly reduced vomerine count which increases (initially at least) with age (size), specimens of less than 40 mm. snout-vent length, which is approximately the lower limit of sexual maturity, are not included in subsequent comparisons between populations.

Sexual Dimorphism

No discernible variation in the vomerine count can be attributed to sexual dimorphism in *Ambystoma macrodactylum*. Using the Idaho sample again, but restricting it to sexually mature individuals of 40+ mm. snout-vent length, the following dispersion of vomerine counts by sex is found:

	Combined Vomerine Count															
	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	N
♂						1		2	2	2	2	2	2	2		15
♀	1	3	1	1	1			2	2	3	4	3	3	2	2	28

Table 3. Variation in combined vomerine counts by sexes in 43 specimens of *Ambystoma macrodactylum* from McCall and Payette Lake, Valley Co., Idaho.

Testing the association between vomerine counts and sex by chi-square, shows that this relationship is very nearly zero (chi-square=0.04), with the observed differences arising purely from random sampling errors. Hence, in making populational comparisons of vomerine teeth variations, the data for the two sexes may be pooled.

Geographic Variation

A distinct east-west differentation is observable in the vomerine count. Specimens from the Columbia Plateaus province in Washington and Oregon show a higher count than do specimens from the Northern Rocky Mountains province in Idaho. Comparison of samples from these two

general regions shows the following dispersions of vomerine counts:

Combined Vomerine Count

	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	N
Idaho		1	3	1	1	1	1		4	4	5	6	5	5	4	2											43
Ore. + Wash.	2					1	1	1		1	3	5	2	3	4	4	4	2	2	3	1	2		1			143

Table 4. Dispersion of combined vomerine counts in 86 sexually mature *Ambystoma macrodactylum* from Idaho, Oregon, and Washington.

A vomerine count of 33 or less distinguishes 32 out of 43 (=74%) Idaho specimens; coversely, 27 out of 43 (=63%) specimens from Oregon and Washington have counts of 34 or more. Testing the association between vomerine counts and geographic origin results in a chi-square value of 12, indicating a highly significant association between the vomerine count and provenance in these two samples.

The vomerine counts of Montana specimens show that they are not distinguishable from Idaho specimens. The five adult California specimens I have seen agree with Oregon and Washington material in their vomerine counts. If the counts of specimens from Montana are pooled with those from Idaho, and these are compared with the counts of specimens from all parts of Oregon and Washington, and northern California, dispersions approximately similar to those shown in Table 4 are obtained. In this instance, out of 73 specimens from Idaho and Montana, 56 (=76%) have counts ranging from 22 to 33, and 17 (=24%) have counts between 34 and 37. In 80 specimens from Oregon, Washington, and California, 53 (=67%) have counts varying from 34 to 47, and 27 (=33%) have counts ranging from 22 to 33. With this larger sample, a chi-square value of 28.3 is obtained in testing the association between geographic origin and the vomerine count. On the basis of these two samples, the probabilities are less than one in a thousand that the observed differences are due to random sampling errors; 109 specimens out of 153 (=71%) can be correctly separated as to geographic origin on the basis of the vomerine count.

RATIO OF HEAD WIDTH TO SNOUT-VENT LENGTH

Head width measurements have been taken with a vernier caliper; the width is measured immediately posterior to the eyes. Snout-vent length is taken as the overall axial length from the tip of the snout to the posterior angle of the vent, along the median ventral line. For the sake of brevity, the ratio of head width to snout-vent length is hereafter referred to as the "HW/SV ratio."

Ontogenetic Variation

A strong ontogenetic variation in the proportionate width of the head is found in *Ambystoma macrodactylum*. Thus, in a small specimen from Payette Lake, Valley County, Idaho (CAS 43539), the head width is 6.3

mm., and the snout-vent length is 31 mm. (HW/SV ratio= 20.3%); conversely, in a larger specimen from the same locality, and taken at the same time (CAS 43556), the head width is 8.6 mm., and the snout-vent length is 55 mm. (HW/SV ratio=15.6%). This trend is well demonstrated in the sample of 45 specimens from Payette Lake and McCall, previously discussed. The variations in the HW/SV ratio in these specimens are shown in Table 5:

Snout-vent Length	HW/SV Ratio (%)	N
31	20.3	1
39	19.2	1
41	17.3	1
43	16.9	1
44	16.8	1
46	16.9-17.4	2
49	17.9	1
50	15.6-17.2	2
51	17.0-17.6	2
52	16.3-17.3	4
53	15.1-17.3	6
54	15.7-16.3	6
55	15.4-17.0	6
56	16.0-16.9	6
57	14.0-15.8	3
59	14.4-15.7	2
		45

Table 5. Variation in the ratio of head width to snout-vent length, by size, in 45 specimens of *Ambystoma macrodactylum* from McCall and Payette Lake, Valley Co., Idaho.

Although there is an overall trend toward a reduction in the relative width of the head in larger specimens, there is considerable overlap. Yet, the association of a relatively wider head with a shorter snout-vent length is clearly shown in the following table:

Snout-vent Length	Range of HW/SV Ratio (%) 14.0-16.5	16.8-20.3	N
31-50 mm.	1	9	10
51-59 mm.	28	7	35

Table 6. Association of HW/SV ratio and snout-vent length in 45 specimens of *Ambystoma macrodactylum* from McCall and Payette Lake, Valley Co., Idaho.

In the sample shown, 37 specimens out of 45 (=82%) can be correctly separated as to snout-vent length on the basis of the HW/SV ratio; a chi-square value of 16.6 confirms the strong association between snout-vent length and the relative head width.

Sexual Dimorphism

Sexual dimorphism in the relative head width, as indicated by the HW/SV ratio, is pronounced. Thus, in a sample of 24 specimens (12 of each sex) in the 51-59 mm. snout-vent size group from McCall and Payette Lake, the males range from 14.4% to 17.9% in their HW/SV ratios; four specimens have ratios of 15.8% or less, the remainder have ratios varying from 16.1% to 17.9%. The 12 females vary from 14.0% to 17.3%, seven specimens having a ratio of 16.0% or less, the remaining five having ratios of 16.3% or more. A chi-square value of 9 confirms the significant association of relative head width and sex in this small sample.

Geographic Variation

Because of the pronounced ontogenetic variation and sexual dimorphism in the relative width of the head, it is necessary in studying the geographic variation in this characteristic to employ specimens of the same sex and comparable size groups.

When such comparisons are made, it is found that Idaho specimens (of both sexes) tend to have proportionately narrower heads than do specimens from Oregon and Washington. Thus, in comparing the relative head width in 12 male specimens (51-59 mm.) from McCall and Payette Lake, Idaho, with an equal number of the same size group from Crater Lake, Oregon, and Lake Cushman, Washington, it is found that with a total range of 14.4% to 17.9%, nine of the Idaho specimens have HW/SV ratios of 16.9% or less, and three have ratios of 17.2% or more. The 12 Oregon and Washington males range from 15.5% to 19.3%, two specimens having ratios of 16.9% or less, and the remaining 10 having ratios of 17.2% or more. Despite the small size of these samples, it is certain that the observed differences do not arise from random sampling errors (chi-square=8.2), and that a relatively narrower head is characteristic of the Idaho males.

Comparison of similar samples of females does not show so definite a degree of association between relative head width and geographic provenance. Hence, 12 Idaho females in the 51-59 mm. class have a HW/SV ratio ranging from 14.0% to 17.3%, with nine specimens having a ratio of 16.3% or less, and three specimens having a ratio of 16.9% or more. By contrast, in 12 Oregon and Washington specimens in the same size group having a total range of 14.2% to 19.5%, seven specimens have ratios of 16.4% or more, and five specimens have ratios of 16.3% or less. Testing the association of these dispersions with geographic provenance, by chi-square, results in a value of 2.75, indicating

that the apparent differences may arise from sampling errors.

However, when larger samples are studied, it is found that as a group, specimens from Oregon and Washington tend generally to have broader heads than do Idaho specimens of equivalent snout-vent lengths. Thus, in comparing 43 specimens of both sexes from Idaho, with a like series of specimens from Oregon and Washington, and plotting their head widths against their snout-vent lengths on a scatter diagram, it is found that a curve computed from the formula

$$(2 \log SV)^2 - (\log SV)^2$$

where SV = snout-vent length, will correctly separate 71% of the 86 specimens regardless of size (see Fig. 1).

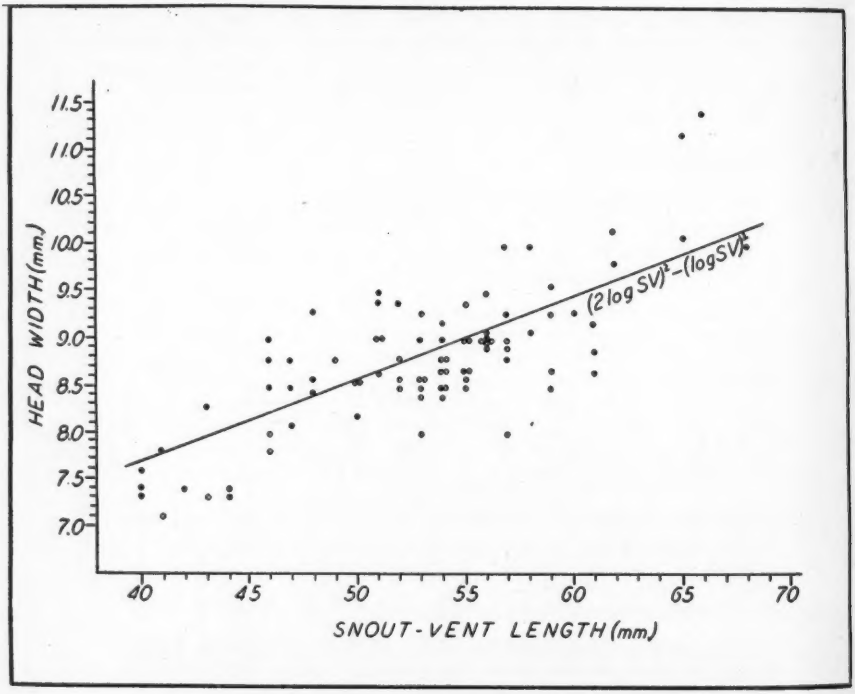

Fig. 1. Association of head width and snout-vent length in 86 *Ambystoma macrodactylum*; hollow symbols represent specimens from Idaho, solid symbols denote specimens from Oregon and Washington. The line computed from the formula $(2 \log SV)^2 - (\log SV)^2$ separates the two samples such that the majority of Idaho specimens fall below it, while the majority of Oregon and Washington specimens fall above it; in all, 71% of the specimens are correctly segregated by the line.

The curve is drawn by computing a series of points from each of the various snout-vent lengths. In each case the formula is applied to a specific snout-vent length (from 40 mm. up to 68 mm.); the value obtained is plotted as an ordinate point (on the head width scale) against a perpendicular from the abscissa scale (snout-vent length). In effect, the value obtained from the formula at any given snout-vent length is roughly analagous to a "standard" head width for that particular length. Hence, the formula may be used conveniently to denote a dynamic dichotomous difference between the two populations involved: Idaho specimens usually falling below the curve (or computed value), while Oregon and Washington specimens usually fall above it. Or, differently put, an Idaho specimen of a given snout-vent length will usually have a head width less than the value resulting from application of the formula against its snout-vent length, while a specimen of the same snout-vent length from Oregon or Washington will usually have a head width greater than the value computed from the formula.

The same dynamic difference in the HW/SV ratio at various snout-vent lengths can be demonstrated by plotting the HW/SV ratio (ordinate) against snout-vent length (abscissa) on a scatter diagram; when this is done, it is found that a curve computed from

$$\frac{(2 \log SV)^2 - (\log SV)^2}{SV}$$

will likewise separate slightly more than 71% of the specimens in the two samples heretofore discussed. Hence, a dichotomous character is obtained in that Idaho specimens usually have a HW/SV ratio less than the value obtained from the preceding formula for any given snout-vent length, while Washington and Oregon specimens usually have a HW/SV ratio which exceeds the computed formulary value.

If 73 sexually mature specimens of 40+ mm. from Idaho and Montana are pooled and compared with 80 similar specimens from Oregon and Washington, either of the two formulas will correctly separate 112 specimens out of a total of 153 (= 73%).

RATIO OF HEAD WIDTH TO HEAD LENGTH

Head length has been measured from the tip of the snout to the midpoint of the gular fold, along the median ventral line; head width measurements have been taken as described previously. For convenience, the ratio of head width to head length is hereafter referred to as the "HW/HL ratio."

Ontogenetic Variation

The HW/HL ratio shows no signifiicant association with age. In a

mixed sample of 43 sexually mature specimens of both sexes from Oregon and Washington, the following variations in the HW/HL ratio are found:

Snout-vent Length	HW/HL Ratio (%)	N
40	69.7-70.5	3
41	70.2	1
42	70.5	1
43	77.5	1
44	66.5	1
46	73.7-76.5	3
47	66.5-75.2	3
48	69.3-73.2	3
50	68.3	1
51	75.7-82.6	2
52	75.2	1
53	71.5	1
54	65.4-69.2	3
55	73.7	1
56	66.1	1
57	72.5-76.9	3
58	66.8-76.9	2
59	60.6-68.0	2
60	70.0	1
61	67.0-68.0	3
62	69.5-72.4	2
65	71.2-77.2	2
66	74.0	1
68	64.4	1
		43

Table 7. Variation in HW/HL ratio in 43 specimens of *Ambystoma macrodastylum* from Oregon and Washington.

From an examination of the data given in Table 7 it is apparent that there is a slight trend toward a lower HW/HL ratio in larger specimens; however, statistical analysis shows that it is insignificant, and in all probability arises from sampling errors. Hence, although it has been shown previously that the relative head width progressively diminishes when compared to the base datum of snout-vent length, it may be concluded that the growth rates of the head width and head length maintain a fairly constant relationship at all ages, and that therefore the relative head width when determined against the base datum of head length does not show an ontogenetic variation.

Sexual Dimorphism

An interesting disparity is found in the degree of sexual dimorphism in Oregon and Washington specimens on the one hand, and those from Idaho on the other, in the HW/HL ratio. In the former, out of 22 sexually mature males showing a HW/HL ratio ranging from 62.8% to 82.6%, 15 specimens have a ratio of 70.7% or more. Out of 21 females varying from 60.6% to 75.0% 16 specimens have a ratio of 70.5% or less. Chi-square is 8.2, confirming the strongly significant association between the HW/HL ratio and sex in these Oregon and Washington specimens.

However, in 15 male specimens from Idaho, the ratio varies from 63.7% to 73.5%, and 10 specimens have ratios of 67.7% or less. Conversely, of the 28 females which range from 61.5% to 76.6%, 16 have ratios of 68.0% or more. Hence, only 26 specimens out of a total of 43 from Idaho can be correctly identified as to sex on the basis of the HW/HL ratio. A chi-square value of 1.9 corroborates the fact that so far as this sample goes, there is not a significant association between the HW/HL ratio and sex in Idaho specimens.

Geographic Variation

Comparison of geographic samples by sexes shows that Idaho males are quite distinct from males taken in Oregon and Washington. Out of 22 sexually mature males from Oregon and Washington, 18 have HW/HL ratios of 69.0% or more; in 15 males from Idaho, 11 have ratios of 68% or less. Hence, 29 specimens out of 37 (=78%) from these three states are correctly identifiable as to geographic origin on the basis of the HW/HL ratio.

Female specimens show no such marked degree of separation. Of 21 females from Oregon and Washington, 13 have ratios of 69% or more; in 28 females from Idaho, 16 have ratios of 68.6% or less. In all, 29 females out of a total of 49 (=59%) can be correctly identified as to geographic provenance on the basis of the HW/HL ratio alone. The chi-square value of these geographic dispersions is 2.1, indicating the probability that the observed differences are not significant.

If all 43 Idaho specimens are compared with the 43 specimens from Oregon and Washington, it is found that 31 of the Idaho specimens have a HW/HL ratio of 69.4% or less; in the Oregon-Washington sample 29 specimens have ratios of 69.5 or more. Thus, 60 specimens out of 86 (=70%) can be properly separated as to geographic origin on the basis of the HW/HL ratio. Chi-square is 13.5, and hence the association between the HW/HL ratio and geographic origin is strongly significant.

When 73 sexually mature specimens from Idaho and Montana are compared with 80 similar specimens from Oregon and Washington, it is found that 55 of the Idaho-Montana series have ratios of 69.4% or less, while 59 of the Oregon-Washington series have ratios of 69.5%

or more. Hence, 114 specimens out of 153 (=74.5%) are separable on the basis of the HW/HL ratio.

COLOR

Relatively stable color differences exist between eastern and western *macrodactylum* (sensu lato). Thus, specimens from Idaho and Montana have a definitely greenish tinge to the dorsal stripe, while the background color of the back tends toward a very dark, almost blackish brown. The sides and belly are liver-brown, or raw umber, usually very prominently maculated with gray, white, or light tan flecks.

In specimens from Oregon and Washington, the dorsal stripe often has a pale bluish or lavender tinge overlaying a basic brown color, while the ground color of the dorsum varies from a light chocolate brown to a darker shade best described as "purplish-brown." The sides and bellies of these western specimens are usually a light tan or grayish brown, and are generally immaculate or but sparsely dusted with tiny whitish or grayish flecks.

Taken in combination, the vomerine count, HW/SV ratio, HW/HL ratio, and color, will correctly separate approximately 85% of the specimens examined from Idaho, Montana, Oregon, and Washington as to geographic origin. The populations of Oregon and Washington generally, as well as the five adult specimens from California which I have seen, closely agree *inter se,* and with Baird's species *macrodactylum* as represented by one of his cotypes (USNM 4042); I therefore restrict the name *macrodactylum* to these populations. Specimens from Idaho and Montana are palpably different from the Oregon-Washington-California series, as heretofore discussed, but are themselves homogeneous; the oldest available name for this easterly form is Peter's *krausei,* which name I accordingly resurrect for this population. Cope's *Ambystoma epixanthum,* as represented by three of his cotypes (ANSP 13880-1, 13883), and Ruthven's specimens of *Ambystoma stejnegeri* supposedly from Iowa, as represented by his type (USNM 78598) and a cotype (USNM 78599), agree closely with Idaho and Montana *krausei,* and are here considered identical with that race.

The Canadian material I have examined (see list of specimens) indicates that *krausei* extends northwestward into British Columbia at least as far as Kamloops. I have not examined any specimens from the northern parts of the Canadian Rockies in British Columbia, but I suspect that such specimens would be referable to *krausei.* Judging from Patch's color description (1922: 75), a specimen from Watson Lake, 45 miles north of Clinton, B. C., seems referable to *krausei,* as does another from Sawmill Lake, B. C., reported by Storer (1925: 73).

A summary of the two races, and of specimens examined, follows:

Ambystoma macrodactylum macrodactylum Baird

1849 *Ambystoma macrodactyla* Baird, Jour. Acad. Nat. Sci. Phila., Ser. 2, vol. 1, p. 292. Type locality: Astoria, Oregon.

Diagnosis: Combined vomerines in sexually mature specimens 34-47

(67%); HW/SV ratio more than the value of $\frac{(2 \log SV)^2 - (\log SV)^2}{SV}$ in 65% of specimens; HW/HL ratio 69.5% or more (74% of specimens); dorsal stripe usually brownish with a bluish or lavender overlay, sides and belly immaculate or but sparsely dotted with tiny flecks; maximum snout-vent length 68 mm. (SU* 1112, Pullman, Washington), maximum total length 133 mm. (CAS 44384, Crater Lake, Oregon), smallest transformed adult 35 mm. total length (PMBC 607, Langford Pond, Victoria, B. C.).

Range: Columbia Plateaus province and the northern Basin and Range province in Washington and Oregon, through the Cascade-Sierra province and Pacific Border province from Calaveras County, California to Vancouver Island and the adjacent mainland in British Columbia; east to Chilliwak, B. C.

*Specimens examined 264, as follows:**

UNITED STATES

California

Alpine County: Pacific Pass (USNM 123596-9).
Eldorado County: Fallen Leaf (CAS 39656-8).
Siskiyou County: Caribou Lake (SU 6406).

Oregon

Clatsop County: Astoria (USNM 4042, *cotype*).
Deschutes County: Deschutes River (USNM 13767, 4 spec.).
Grant County: Strawberry Mountains (USNM 53129).
Klamath County: Ft. Klamath (USNM 8863, 3 spec.; 14725); Crater Lake (USNM 39549-672, 39872-882, 95225; SU 3866-74; CAS 44381-6, 44592, 44611-3, 44616).
Wallowa County: Wallowa Lake (USNM 39531-6).

Washington

Clallam County: Port Angeles (CAS 13213).
Gray's Harbor County: Hoquiam (CAS 39201).
King County: Seattle (SU 2238).
Kitsap County: Gorse Creek (USNM 62711).
Lincoln County: Odessa (USNM 61467).
Mason County: Lake Cushman (CAS 64730-1, 64734-5, 64737, 64743-4, 64746).
Pierce County: Mt. Rainier (CAS 30003; USNM 62496-502).
Skagit County: Lyman Lake (USNM 61389).
Snohomish County: Suiattle River (USNM 61469).
Walla Walla County: Walla Walla (USNM 10922, 4 spec.; 11468, 11591, 6 spec.; 14466, 2 spec.).
Whitman County: Pullman (USNM 26629; SU 1111-4; CAS 64846-7, 64852-3, 64858-9).
Yakima County: Cowlitz Pass (USNM 60275-6).

*Abbreviations for collections as follows: USNM (United States National Musec); CAS (California Academy of Sciences); SU (Leland Stanford Jr. University Museum); ANSP (Academy of Natural Sciences

of Philadelphia); PMBC (Provincial Museum of British Columbia); UADZ (University of Alberta), Department of Zoology); ROMZ (Royal Ontario Museum of Zoology).

CANADA

British Columbia

Crotean Lake, Vancouver Id. (PMBC 758); Savory's Pond, Langford (PMBC 635); Hope-Princeton (PMBC 674); Langford Pond, Victoria (PMBC 607, 3 spec.); N. Fork Moose River (USNM 48615-6); Chilliwak Lake (USNM 5982, 13 spec.); Hatzic (ANSP 10518-22).

Ambystoma macrodactylum krausei Peters

1882 *Amblystoma Krausei* Peters, Sitz-Ber. Ges. Nat. Fr. Berlin, 10, p. 145. Type locality: Flathead River, Montana.

1883 *Ambystoma epixanthum* Cope, Proc. Acad. Nat. Sci. Phila., p. 16. Type locality: South Boise River, Idaho.

1912 *Ambystoma stejnegeri* Ruthven, Proc. U. S. Nat. Mus., 41, p. 517. Type locality: Bloomfield, Davis County, Iowa.

Diagnosis: Combined vomerines in sexually mature specimens 22-33 (76% of specimens); HW/SV ratio less than the value of $\frac{(2 \log SV)^2-(\log SV)^2}{SV}$ in 85% of specimens; HW/HL ratio 69.4% or less in 75% of specimens; dorsal stripe usually tinged with green, sides and belly usually prominently maculated with gray, white, or light tan; maximum snout-vent length 59 mm. (CAS 45827, 45847, McCall, Idaho), maximum total length 118 mm. (CAS 45847), smallest transformed adult 48 mm. total length (ANSP 13883, Atlanta=South Fork, Boise River, Idaho).

Range: Northern Rocky Mountains province in Idaho and Montana; southwestern Alberta; British Columbia as far west as Kamloops and probably north to about Lat. 58°; Iowa (?).

Specimens examined, 125, as follows:

UNITED STATES

Idaho

Blaine County: Sawtooth Lake (USNM 16792).

Bonner County: Priest Lake (CAS 63841).

Camas County: South Fork of Boise River (ANSP 13880-1, 13883. Cotypes *epixanthum*).

Valley County: Lardo (USNM 40123); Payette Lake (USNM 39536; CAS 43539, 43541-2, 43546, 43548, 43550, 43555-6, 43580-1); McCall (USNM 61131-42; CAS 45821-7, 45830-45, 45847, 45849, 45852-7, 45860, 45862).

Montana

Glacier County: Lake Evangeline, Glacier National Park (USNM 102456-73).

Treasure County: Fort Custer (USNM 14524).

Iowa (?).

Davis County: Bloomfield (USNM 78598-9, type and paratype *A. stejnegeri*).

CANADA

Alberta

Banff (USNM 73676-704; ROMZ 4435); Lake Edith, Jasper (UADZ, 2 spec.).

British Columbia

Kamloops (PMBC 666-8, 691, 694); Okanagan Landing (PMBC 28, 790, 2 spec.);

Cranbrook (PMBC 29).

Acknowledgments

Many institutions and individuals have very kindly cooperated in the present study by lending specimens; in this connection I should like to acknowledge the courtesy extended by Dr. E. R. Dunn, Dr. Doris M. Cochran, Dr. Alexander Wetmore, Dr. G. S. Myers, Mr. Joseph R. Slevin, Dr. I. McT. Cowan, Dr. William Rowan, Dr. G. Clifford Carl, and Mr. E. B. Shelley Logier. My wife has been of the utmost help in assisting me with statistical tabulations, for which she has my thanks.

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470 PELHAM ROAD, NEW ROCHELLE, NEW YORK

Report on the Chicago Meeting

The Herpetologists League met jointly with the Ecological Society of America, through the courtesy of Dr. William A. Dreyer, at 2:00 P.M., Dec. 29, 1947 at the Congress Hotel in Chicago. This was our second meeting under the auspices of the A.A.A.S. Dr. Hobart M. Smith, our President, presided.

The following papers were given:

The reptiles and amphibians of eastern central Illinois, Dr. Philip W. Smith, Ill. Nat. Hist. Survey, Urbana, Ill.

Observations on constancy of color and pattern in soft-shelled turtles, C. Wm. Nixon, U. of Ill.

Hibernation of the alligator in an artificial environment, Dr. Albert W. Reese, W. Va. University.

A taxonomic and statistical study of the keeled green snake, *Opheodrys aestivus,* Leslie W. Burger, U. of Ill.

Notes on the tadpole and natural history of *Rana areolata circulosa,* Dr. Hobart M. Smith, C. Wm. Nixon and Dr. Philip W. Smith, U. of Ill. and Johns Hopkins U.

The influence of moisture on the local distribution of some North Carolina salamanders, Nelson G. Hairston, Northwestern U.

Seasonal changes in populations of the red-backed salamander, *Plethodon cinereus,* Frederick H. Test, U. of Mich.

Forty-eight members and guests attended.

At a business meeting it was decided: 1. To meet regularly with the National and Sectional A.A.A.S. congresses; 2. Publish a complete volume of Herpetologica per calendar year; 3. A desire was expressed for card-sized membership certificates. Certificates using the pleasing drawing made by our member, Mr. Mansueti, are being distributed as a result.

Next Meetings of the Herpetologists League

The next meeting will be with the Southwestern Division of the A.A.A.S. at the New Mexico Highlands University, Las Vegas, New Mexico, May 3-6, 1948.

We will meet June 21-26, 1948 at the U. of Cal., Berkeley, with the Pacific Division of the A.A.A.S.

Please inform the Editor as to which meetings you can attend and whether you will present a paper or contribute one to be read. Promptness in cooperation will lighten administrative work. The Editor should have your replies at least six weeks before a meeting date.

Unfortunately, societies will not meet at the A.A.A.S. Centennial in Washington in Sept., 1948.

Notes on Some Okinawan Amphibians and Reptiles

By HAROLD L. ROSENTHAL

Information concerning the amphibians and reptiles of the Japanese Empire is contained principally in the works of Stejneger (1907), Maki (1931), and Okada (1931). These reports are based primarily on the description of preserved museum specimens. An opportunity for me to study some of the herpetological fauna of Okinawa in its native environment was made available while on duty with the Armed Forces. It is believed that the observations presented here will contribute to our knowledge of the reptiles and amphibians of Japan.

The Ryukyu Archipelago lies in a northeast-southwest plane between Japan and Formosa. Okinawa is the main island of the group. It is approximately 60 miles long and 4 to 16 miles wide (Fig. 1). The northern portion of the island, of Paleozoic origin, (Okada, 1931), is rocky and mountainous, covered by sparse vegetation and stunted woods. The southern portion differs from the northern in its rolling hills and plateaus with heavy vinelike vegetation that covers the eroded coral-reef limestone formation. A low coastal area, encircling most of the island, is under heavy rice and sweet potato cultivation. The plateau rises sharply from the coastal area to an altitude of 150 meters at Kokihana. A rather mild, almost subtropical climate prevails throughout the year. The highest temperature noted was 94° F. in August 1945, and the lowest was 47° F. in January, 1946.

I collected thirty-one specimens of amphibians and reptiles from the southern portion of the island between July and November, 1945. These represent one species of salamander, three species of frogs, one species of lizard, and four species of snakes. The coloration was observed in living specimens. This collection has been deposited in The American Museum of Natural History, and all specimen numbers refer to that Museum.

AMPHIBIA

CAUDATA

Triturus ensicaudus (Hallowell). Two males (A 52821-22) and two females (A 52823-24) were collected near Hyakuna, September 23, 1945. The males were in breeding coloration, although the females did not contain mature eggs. The basic coloration of the two sexes is similar: solid black above from snout to tip of tail, with dull, indistinct irregular buff patches along the dorso-lateral surfaces of back, tail and legs. The throat, abdomen, ventral surface of legs and ventral surface of tail were deep orange, spotted with irregular, oblong, black blotches of varying size and number. Spotting of the ventral surface varied from one or two small spots to a point where the abdomen was almost entirely black. The breeding coloration of the male differs from the female only in the intensification of the orange coloration and the appearance of a bright orange lateral line from the snout to the tip of the tail. None of the specimens showed any over-development of the parotoid or other glands, while the

entire dorso-lateral aspects of the skin were covered with very fine tuberculate processes.

MEASUREMENTS:	A 52821 ♂	A 52822 ♂	A 52823 ♀	A 52824 ♀
Total length	139 mm.	148 mm.	112 mm.	115 mm.
Vent to tip of tail	80 "	77 "	57 "	58 "
Tip of snout to gular fold	13 "	15 "	14 "	13 "
Width of head	13 "	13 "	12 "	13 "
Length of foreleg	17 "	16 "	14 "	16 "
Length of hindleg	18 "	16 "	15 "	15 "
Length of longest toe (hind foot)	6 "	5 "	5 "	5 "
Height of tail	7 "	6 "	8 "	7 "

This salamander was very common among the eroded limestone rock of the area, appearing in large numbers during and after rains, and withdrawing to crevices and caves whenever conditions became dry. Wherever standing rain water was available (most rice paddies and pools were either drained or sprayed for mosquito control) groups of 2 to 10 individuals could always be found. Neither mating, eggs nor larvae were observed at any time. It is interesting to note that the DDT in oil used as an antimosquito spray was fatal to these salamanders. Large numbers of dead salamanders were observed along the edges of treated rice paddies and pools.

SALIENTIA

Microhyla fissipes Boulenger. An adult male (A 52812) was found at Kokihana, November 5, 1945, under a piece of tin alongside a drainage ditch. Although the day was fairly warm, the specimen was not very active, and was easily caught. An adult female (A 52813) was collected at Hyakuna, September 19, 1945, under a piece of tarpaulin. It made no attempt to escape. The female was slightly larger and more robust than the male.

The coloration of the male and the female is similar; tan above with large grayish black markings. A thin pale dorsal median line extends from the tip of the snout to the anus. From a black V shaped mark between the eyes, a broad wavy black band extended along each side of the median line, ending in transverse bars across the femur. The lateral surface, from snout to vent, was grayish black, as was the ventral surface of the fore and hind legs, the edges of the throat, and the chin. The abdomen was immaculately white.

MEASUREMENTS:	A 52812 ♂	A 52813 ♀
Total length (snout to vent)	23 mm.	26 mm.
Width of head	7 "	8 "
Length of foreleg	12 "	15 "
Length of hindleg	45 "	43 "
Length of tibia	14 "	15 "

Tadpoles (A 52816) were discovered at Hyakuna, September 21, 1945, in a rain-filled shell hole about two feet in diameter, and one foot in depth. This shell hole was dry prior to the typhoon of September 16, 1945. It is assumed, therefore, that the tadpoles were 6-7 days old when collected. Seven tadpoles varied in size from 10 mm. to 12 mm. in total length, with tail length from 5 mm. to 7 mm. No oral dentition was present in these specimens. Coloration was almost absent, although a fine black speckling was present on the dorsal surface and along the dorsal edges of the tail. By reflected light the entire body possessed a golden hue. The intestines were metallic blue in direct light, but a deep gold in reflected light.

Five tadpoles (A 52814), from the same shell hole, were collected 8 days later, September 29, 1945. At this time the tadpoles varied from 18-21 mm. in total length, with tail length from 10-12 mm. In the eight-day interval, these tadpoles increased about 8 mm. in total length and 5 mm. in tail length.

On September 2, 1945, many tadpoles (A 52815) of the same species, but in different stages of development, were found in a village bathing pool at Hyakuna. Two tadpoles ready to metamorphose and two juvenile frogs were collected. These tadpoles were 28 mm. and 32 mm. in total length with the tail 19 mm. and 22 mm. long respectively. These older tadpoles differ from the younger ones (A 52816) by the absence of the golden hue, and by an increased amount of speckling of both body and tail. The total length of the two juvenile frogs were 8 mm. and 9 mm. respectively, not including the stub tail, which was still present at this time. On close examination of the juvenile frogs, indistinct outlines of adult coloration could be seen on the dorsal surface, otherwise the coloration was basically the same as that of the larger tadpoles (A 52815).

Rana limnocharis Wiegmann. Three adult females (A 52817, A 52818, and 1 untagged), two adult males (untagged) and five young frogs (untagged), were collected in a rice paddy at Myazato, July 18, 1945. All of the adult females contained mature ova. The coloration of the adult females varied from dark brown to deep green with blackish, irregular, oblong markings above and on the legs. A dark V shaped mark between the eyes and a black W on the back was present in all specimens. Small, longitudinal, glandular ridges were present on the dorsum in some specimens, and absent in others. The abdomen and throat were immaculately white. When disturbed or handled, a greenish flush appeared over the body of some, but not all specimens. The two adult males had the same basic coloration as the female with the exception that in the males the throat was marked with a broad dusky band involving the vocal sacs. Some males were also observed to have a small, orange, crescent-shaped spot immediately behind the tympanum. The young frogs were identical with the females.

MEASUREMENTS:	Male (Largest)	Female (A 52817)	Young (Largest)
Total length (snout to vent)	37 mm.	41 mm.	24 mm.
Width of head	11 "	12 "	6 "
Length of foreleg	18 "	20 "	13 "
Length of hindleg	46 "	46 "	35 "
Length of tibia	13 "	14 "	10 "

This species was by far the most common frog on the island. It was found in the vicinity of every rice paddy, ditch and shell hole which was either damp or filled with water. All stages in the life cycle from the egg to the adult were observed in large numbers from March until August. The apparent absence of frogs from early December to late February seems to indicate a period of hibernation. Mating was observed to occur primarily in the evening, night and early morning, although a few clasping specimens were found during the day. The eggs were laid singly but were often found floating on the surface of the water either alone or in aggregates of 2 to 50 in the early morning. Later in the day, the eggs sank to the bottom of the pools where they hatched. These floating eggs were observed only in artificial pools and puddles formed in the clearing of camp sites. The eggs measured 2 mm. in diameter with a capsule 5 mm. in diameter. Eggs collected at 8:00 A.M., August 26, 1945 and kept in my tent began to hatch after 28 hours. Nine days later, September 4, 1945, the tadpoles varied from 18 mm. to 23 mm. in length from snout to tip of tail.

Fifteen tadpoles (A 52819) collected at Myazato, July 19, 1945, varied in size from 20 mm. to 27 mm. in total length, with tail lengths from 12 mm. to 18 mm. Coloration was dull gray above with heavy speckling of small black spots, including both dorsal and ventral edges of the tail. All of the preserved specimens had hind leg buds. The dentition of $\frac{1:1+1}{3}$ differs from the dentition of $\frac{1:1+1}{1:2+2}$ given by Okada.

Rhacophorus viridis (Hallowell). One female specimen (A 52820) was collected at Hyakuna, October 6, 1945, among the litter of leaves in a small wooded area. The dorsal surface was smooth and deep green with a few almost indistinguishable round, dark spots on the posterior portion of the back. The entire ventral surface, including the inner surface of the legs, was deep lemon yellow and immaculate. A series of very small black spots was present along the upper, posterior dorsal surface of the femur.

MEASUREMENTS:

Total Length (snout to vent)	53 mm.
Width of head	11 "
Interorbital space	5 "
Diameter of tympanum	3 "
Length of foreleg	45 "
Length of hindleg	87 "
Length of tibia	20 "

REPTILIA

SAURIA

Gekko japonicus (Duméril and Bibron). A male (AMNH 67193) was collected at Kokihana, October 3, 1945. The coloration was brown above with very faint transverse bands encircling the tail. The ventral surface was buff colored.

MEASUREMENTS:

Total length	96 mm.
Snout to vent	50 "
Vent to tip of tail	46 "
Snout to ear opening	8 "
Width of head	11 "
Length of foreleg	16 "
Length of hindleg	23 "

This specimen was mistaken for the salamander, Triturus ensicaudus, since it was clinging to the muddy wall of a cave with other salamanders. However, its large eyes, with vertical pupils, indicated its true identity. These geckos were the most common lizards on the island and were frequently observed in the native houses and in our tents at night. During the day they remained concealed, but as evening approached, they appeared in large numbers to feed on the insects which were attracted to our camp lights.

SERPENTES

Typhlops braminus (Daudin). Two juvenile specimens of this burrowing snake were found under a tarpaulin at Hyakuna. AMNH 67195 was collected September 19, 1945, while AMNH 67194 was collected from under the same tarpaulin September 25, 1945. The coloration was dark brown above, paler below with white tipped tail and chin. Scale rows of both specimens numbered 20.

MEASUREMENTS:	AMNH 67194	AMNH 67195
Total length	63 mm.	62 mm.
Tail length	5 "	5 "

Larger, slate gray specimens, presumably of the same species, were observed in other collections on the island. Some of these specimens were approximately 17 cms. long.

Achalinus loochooenis Thompson. Three specimens were collected at Hyakuna. An adult female specimen (AMNH 67196) was collected September 29, 1945, in a sugar cane patch; an adult male (AMNH 67198) was collected October 5, 1945, in a pile of sugar cane refuse; and a juvenile specimen (AMNH 67197) was collected, October 16, 1945, on a rainy, chilly day, under a piece of board.

Both adult specimens were grayish brown above with an obscure, dark median stripe. The ventral surface was pale yellow except for a thin brown line which began midway along the abdomen and extended to the

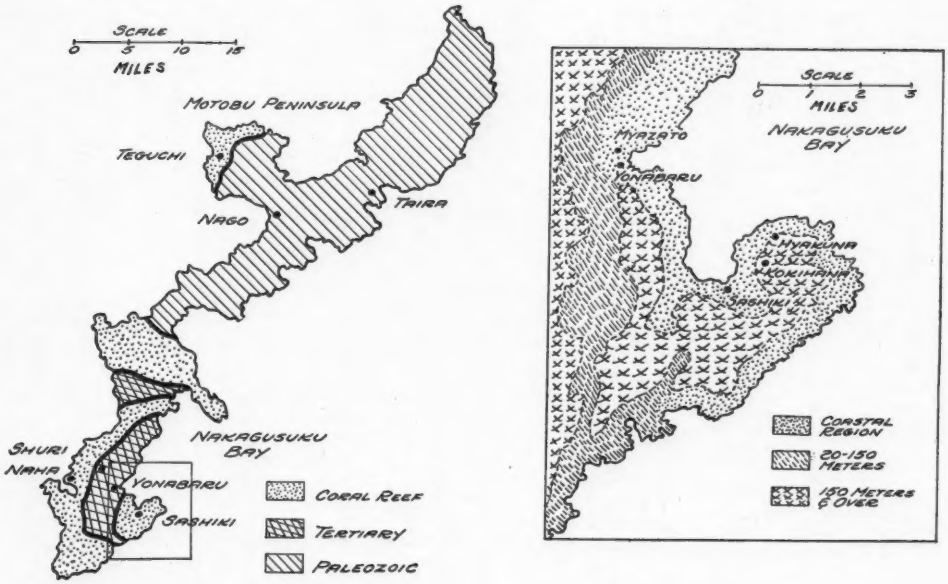

FIG. 1 OKINAWA (SCHEMATIC) - ILLUSTRATING THE GEOLOGICAL FORMATION, THE LOCATION, AND THE APPROXIMATE ALTITUDE OF THE COLLECTING AREA. (FROM OKADA)

tip of the tail. The coloration of the juvenile was considerably different from that of the adults. Its basic color was essentially black above and below; however, the free edges of the ventral scales were bordered with white, giving the ventral surface a pale gray appearance.

All of the specimens possessed the same head and dorsal scutellation; upper labials 6, lower labials 6, preoculars absent, loreals 1, post oculars abent, temporals 2x2, scale rows 23. The scale counts of the three specimens differed considerably, as shown below:

	67196♀	67197 (Juvenile)	67198♂
Ventrals	174	164	171
Subcaudals	85	76	96
MEASUREMENTS:			
Total length	373 mm.	195 mm.	345 mm.
Tail length	85 "	53 "	94 "

Both adult specimens had been feeding on earthworms. The male and female regurgitated one and two worms, respectively, when collected.

Trimeresurus flavoviridis flavoviridis (Hallowell). A male specimen (AMNH 67200) was killed at Hyakuna shortly before daylight November 9, 1945. It was deep green above with dark irregular markings along the entire dorsal aspect. The ventral surface was cream colored, with the same irregular markings as the dorsal surface. The head and dorsal scutellation agrees with the descriptions given by Stejneger and by Maki: upper labials 8, lower labials 15, scale rows 29-32-33, ventrals 226, subcaudals 86.

MEASUREMENTS:	
Total length	1674 mm.
Tail length	272 mm.

On measuring the specimen in the field, it was found to have a total length of approximately five feet, eight inches. The natives of Okinawa were terrified by this snake which they called the "Habu." Two varieties are recognized by the natives, the "Habu," and the "Ka Habu," or Golden Habu. The native snake-catcher at Nago showed me two living "Ka Habu's." They were approximately three and a half feet in length, similar in all respects to the "Habu" except that the coloration was pale golden green instead of dark green. The snake-catcher also stated that the "Ka Habu" never attained any greater length or change in color and that it was not the same species as the "Habu." Whether or not these two are variations of the "Habu," or are separate forms, has not been determined.

Trimeresurus okinavensis Boulenger. A male specimen (AMNH 67199) was caught in the early morning at Hyakuna, November 10, 1945. Coloration above was dull brown, marked with irregular dark blotches. A prominent black band, bordered above by a conspicuous white band, was present from the eye to the angle of the jaw. The ventral surface was tan and without markings. The scutellation agrees with the description given by Maki: upper labials 8, lower labials 10, dorsal scale rows 23, ventrals 129, subcaudals 52.

MEASUREMENTS:

Total length ..... 637 mm.
Tail length ..... 113 "

This reptile is called the "Mamushi" by the natives. At least 50 specimens were killed in the immediate vicinity of Kokihana during the month of October, 1945. Many specimens were destroyed in the native tombs of the area. These tombs seem to be "dens" for daily aestivation, a phenomenon also observed by Pendleton (1947), on Guadalcanal.

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Natrix sipedon compressicauda at Key West, Florida

By PAUL L. SWANSON

During the last two weeks of January, 1947, my brother and I collected 16 specimens of *Natrix sipedon compressicauda* (Kennicott) from ponds on the golf course at Stock Island, adjacent to Key West, Florida. 12 of these were caught from an open pond on the fairway. The pond is bordered by grass, has no outlet or inlet, and is rather stagnant, the turbid water being only slightly brackish to the taste. It is about 100 feet in diameter, and the aquatic weeds along the shore line afford good cover for many small fishes. This aquatic vegetation grows only to the surface of the water, and most of our snakes were caught resting on these weeds where they were apparently watching for minnows to come within range.

One night just as I seized one of these snakes, the snake grasped a killifish (*Fundulus seminolis*) in his jaws, under the full glare of the flashlight. It appeared as though it actually located its victim with the aid of the light. While I held the snake in my hands, it worked the fish around so that the head was in its mouth, and then promptly swallowed it, apparently quite unconcerned about being captured.

There are two other ponds on the golf course; they are situated in a growth of brush and small trees. During high water stages, they are connected by a drainage ditch to the Gulf, but the tides do not ordinarily affect them. At the time we were there, the water was not very salty to the taste. One of the ponds is much larger than the one on the fairway, the other is rather small. They contain aquatic vegetation and brush, along the shore line, and a good supply of small fishes. We caught three snakes from the smaller pond, but only one from the large one. The total of 16 from the three ponds were caught during six different night trips. During eight trips by daylight we saw no snakes whatsoever. The ditch mentioned above teemed with the right-sized fishes for snakes to feed upon, but no snakes were observed in it, either by day or night. I also hunted for water snakes along the shoreline, along jetties, in the mangroves, and in tidal pools, on many occasions, day and night, but the only places where I observed any were in the ponds on the golf course.

Three of the snakes were crawling about when observed, three of them had only their heads thrust up through the weeds, and ten were stretched out on the surface of the water, their weight supported by the vegetation.

The specimens ranged from 392 mm. to 656 mm. in total length, and averaged about 546 mm. They range in color from reddish orange, tan and brown, to dark gray and black. Most of the reddish specimens have no markings; the tan ones show faint cross bands, but the darker ones are conspicuously banded. Of the 16, 11 were of the tan or reddish phase, and 5 were dark. Such color variations are known to show up in a single brood of young, and they cannot be attributed to sexual dimorphism.

Snakes of this species are moderately slender in form, somewhat like the common eastern garter snake. The red ones in particular are very handsome. The vicious demeanor so often noted in some of the species of *Natrix* is lacking in this one. Neither in catching them nor in frequent

handling subsequent to their capture have any of them ever attempted to bite.

My specimens fed readily in captivity. While crowded into a small box at Key West, they readily ate small fishes caught from their native ponds. After taking them to my home in Pennsylvania, they ate small sunfish, strips of cut fish purchased at the market, and several adult specimens of the salamander *Ambystoma jeffersonianum*. An adult *Ambystoma maculatum* was left in the cage overnight, and several of the snakes grasped it in their jaws momentarily, but then released it. Large earthworms were grasped and released, after which the snakes rubbed their mouths against stones as if to rid themselves of a bad taste.

13 of the snakes were taken north alive in a small cloth sack, in which they were confined for 9½ days. At one time the temperature dropped as low as 35° F. They were then placed in a 15-gallon aquarium, covered by a screen, with a third of the bottom as dry land, the remainder with about two inches of water. Two hours after being placed in this cage, I observed a pair copulating. I thought I had noticed similar activity while they were in the small cage at Stock Island, but due to their crowded condition plus poor visibility into the cage, I wasn't certain. This time I lifted the snakes out and examined them, and there was no doubt about it.

One of the specimens was repeatedly observed attempting to mate with several of the others from February 11 to February 22. With the exception of the instance noted above, none of the subsequent attempts was successfully completed while I was watching. Since the advent of captivity seemed to disturb them so little in regard to feeding or mating, it may be assumed that the time of mating was not greatly affected by their short period of captivity prior to the event. Probably mating takes place in the vicinity of Key West between the dates of January 24 and February 22. I am convinced that the male must have more than passive cooperation in order to successfully complete copulation. While the females made no attempt to avoid him, they were entirely unconcerned with his overtures.

The mating attempts usually proceeded as follows: the male approached a female and followed her body with his snout until his head covered hers. His head, and often parts of his body, would twitch in erratic little jerks, whether or not he was in contact with the female. When actually in contact, this jerking motion had the effect of a rubbing motion. After such preliminary activity, the remaining effort was made by the tail and the posterior portion of the body. At this stage, the heads were sometimes far apart, and the anterior portions of the bodies often not even parallel. The male thrust a U-shaped loop of the tail beneath the posterior portion of the female in an apparent effort to locate the cloaca. The bodies of the snakes were always in a normal position insomuch as the dorsal surfaces of both were always uppermost, with the exception of a very small part of the posterior part of the male that was being used in an exploratory effort to locate the female's cloaca.

I kept six of the snakes alive until late summer, at which time I loaned them to a friend to care for until spring. None of them bore any young.

RFD 2, POLK, PA.

Hibernation of Amphibians and Reptiles in Richmond County, Georgia

By WILFRED T. NEILL

Remarkably few hibernation records have been published, although the winter behavior of amphibians and reptiles is highly interesting and merits further study. The following remarks are based on observations in Richmond County, Georgia, except as otherwise noted. The list is confined to those species of certain occurrence in the county, and constitutes a check-list for the area. The term hibernation has been extended to include any sort of retreat from winter conditions, whether or not actual dormancy is involved.

Necturus punctatus.—No hibernation; frequently seen in the water at night in midwinter.

Amphiuma means means.—Disappears from its customary haunts with the advent of cool weather; often dug from bogs or muck.

Triturus viridescens viridescens.—Aquatic adults active all year; terrestrial larvae beneath fallen timbers and piles of debris in thick woods.

Triturus viridescens louisianensis.—No winter records; neotinic here.

Ambystoma maculatum.—No hibernation; usually seen above ground only in winter; breeds in December and January in this area.

Ambystoma opacum.—Active all winter; found beneath logs and debris at all seasons.

Ambystoma talpoideum.—Found above ground only in winter; occasionally dipped from breeding ponds in December.

Ambystoma texanum.—The only Richmond County specimen was found beneath a board in a damp, forested area, in December.

Ambystoma t. tigrinum.—Similar to *A. maculatum.*

Desmognathus fuscus fuscus.—Little affected by low temperatures; found throughout the year beneath debris near ponds or streams.

Desmognathus fuscus auriculatus.—Habits like the typical race. One winter evening I collected the form from beneath boards beside a small stream, the air temperature being 28 F at the time. Early the next morning, with the temperature at 32 F, I found more specimens under the same cover. When grasped, they lay quiescent a moment longer than usual, but otherwise seemed unaffected by the cold. The boards were on solid ground; and the salamanders had evidently crawled under them during the night, with the air temperature at least down to freezing.

Plethodon glutinosus glutinosus.—Retires to the interior of a rotten log, or burrows far into a decaying stump; very active when uncovered, however.

Hemidactylium scutatum.—The few Richmond County specimens were all found beneath boards in midwinter, which seems to be its breeding season in this area.

Pseudotriton montanus flavissimus.—No particular winter retreat; found beneath logs in and about ponds and small streams at all times; always active when disclosed. Many examples approach typical *montanus*; trinomials are apparently warranted.

Pseudotriton ruber vioscai.—Leaves the ponds and streams in winter,

hiding beneath decaying logs some distance from water; rather passive when disclosed. This is one of the few plethodontids that might be said to hibernate. Occasional specimens forage in winter, however.

Eurycea bislineata cirrigera.—Active all year; breeding in winter.

Eurycea longicauda guttolineata.—Active all year, but somewhat less so in cold weather; sometimes overwinters in piles of mud and dead leaves along stream margins, or in cracks in shale rock.

Manculus quadridigitatus quadridigitatus.—Active all year, but less common in winter.

Siren intermedia intermedia.—Disappears from its customary haunts in late autumn; occasionally dug from sphagnum bogs.

Siren lacertina.—No winter records.

Scaphiopus holbrookii holbrookii.—Little seasonal variation in habitat; in ground burrows throughout the year.

Bufo quercicus.—No winter records.

Bufo terrestris terrestris.—Often found in or beneath rotting logs, occasionally in rotting stumps; also in ground burrows; active when disclosed.

Bufo woodhousii fowleri.—Similar to *B. t. terrestris.*

Acris crepitans.—Found hopping about pond and stream margins at all seasons. Occasionally hiding beneath logs.

Acris gryllus gryllus.—Similar to *A. crepitans.* On very cold days they seem numb and scarcely capable of jumping.

Pseudacris nigrita nigrita.—Most active in winter; begins calling with the advent of cold weather.

Pseudacris nigrita feriarum.—Similar to the typical form. I have often heard it calling when the air temperature was several degrees below freezing and the breeding ponds were skimmed over with ice.

Pseudacris ornata.—Similar to *P. n. feriarum.*

Hyla andersonii.—The only Georgia specimen was found beneath loose bark of a standing tree on a cool day.

Hyla cinerea cinerea.—Sometimes found beneath the bark of rotting pines, usually two or three specimens together; very active when disclosed.

Hyla crucifera crucifera.—Seldom found except during the colder months; breeds in winter in this area.

Hyla femoralis.—One specimen dug from the pulpy wood of a decaying log in a thick forest, on December 27, 1946.

Hyla gratiosa.—No winter records, although the form is fairly common in the county.

Hyla ocularis.—No winter records.

Hyla phaeocrypta.—No winter records, although the species is very common in the southern part of the county.

Hyla squirella.—Found in or beneath decaying logs in moist woods or bottomlands; active when disclosed. Also overwinters in deserted farm houses and barns, and beneath the bark of tall, dead trees.

Hyla versicolor versicolor.—No winter records for this common frog.

Rana catesbeiana.—Beneath stones, logs, or piles of trash near or in the water; also in tunnels beneath the banks of streams. Occasional specimens are found in winter beneath small stones or bark scraps that scarcely suffice to cover their bulk. Capable of leaping for the water when disturbed.

Rana clamitans.—Beneath stones or logs near or in the water; in holes beneath stream banks; active when disclosed.

Rana grylio.—No winter record for this frog, which inhabits a few lakes in the southern part of the county.

Rana heckscheri.—No winter records, although the species is found in a few streams in the southern part of the county.

Rana pipiens sphenocephala.—Similar to *R. clamitans.*

Microhyla carolinensis carolinensis.—Overwinters in rotten logs, and is sometimes found beneath the bark of a decaying pine stump three or four feet above the ground; always very active when uncovered.

Alligator mississipiensis.—Disappears in the autumn, and is said to overwinter in chambers beneath the banks of lakes or streams. However, one large 'gator spent the winter in a mud-hole beneath a great pile of logs thrown up by a freshet. Occasionally seen in the open in winter, perhaps having been disturbed in its retreat.

Anolis carolinensis.—A gregarious hibernator, most frequently found beneath the bark of old hardwood stumps, usually near a stream. I have found as many as 29 in the same stump. A friend and I found 108 specimens in stumps along the margin of Rae's Creek, in about 100 yards distance. It is not uncommon to find 6 or 8 anoles nestled beneath a small rotten log or bark scrap; such specimens are often covered with frost in the early morning. Hibernating specimens are incapable of running. When grasped they writhe awkwardly, with open mouth and, if a male, with expanded gular fan. Such examples are always dark brown in color. The species is one of the first to appear in spring, and will also emerge in warm days of winter.

Sceloporus undulatus undulatus.—Hibernates beneath the bark of pine stumps, in large fallen logs, or in burrows on red clay hillsides. Usually found singly; occasionally 2 or 3 specimens together.

Sceloporus undulatus hyacinthinus.—Similar to the typical form. Both races can only writhe, open-mouthed, when disturbed.

Ophisaurus ventralis ventralis.—Often unearthed by fishermen digging for worms in loamy soil.

Cnemidophorus sexlineatus.—Remains abroad late in autumn, but is the last species to emerge in summer. Overwinters in ground burrows, not in stumps or logs, singly or in twos or threes. The burrows usually terminate beneath a large rock, under which the lizard may be found. Hibernating examples in red clay regions are coated with the ferruginous soil. Can only writhe and gape when unearthed.

Leiolopisma laterale.—In and about fallen logs, stumps, piles of dead grass, rubbish heaps, cardboard, tarpaper, etc. Fairly active when disclosed, even in coldest weather.

Eumeces fasciatus.—Least particular of the blue-tailed skinks in its choice of winter quarters. Found in old stumps, fallen timber, and piles of debris, or beneath rocks and ground litter. I often uncover dead, frost-rimmed specimens beneath scraps of rotting wood; I believe such lizards froze to death. Found singly or in pairs; can only gape and twist when uncovered.

Eumeces inexpectatus.—Beneath bark of pine or hardwood stumps;

never beneath ground debris. Usually found singly. No frozen examples noted. Behaves like *fasciatus* when exposed.

Eumeces laticeps.—Very particular in its choice of a winter retreat, adults being confined almost entirely to very large rotting pine stumps, particularly tall ones and leaning ones. If leaning pine stumps are available, the lizards will not be found in vertical ones—an odd circumstance, but one too often noted to be mere coincidence. Two or three specimens usually hibernate together in cavities of the pulpy wood, often ten feet or more above ground. When disclosed they are usually curled up, and are almost helpless. When touched they writhe and gape; they will pinch severely if given a chance. Many examples are covered with a waxy exudation, which I believe to be a secretion from the lizard itself rather than from the surrounding medium. This exudation has not been noted in other species. Juveniles occasionally overwinter beneath ground debris. All three species of blue-tailed skinks emerge early in spring.

Eumeces egregius.—Remains below ground in small ramifying tunnels in sandy soil throughout the year. They come to the surface at the first definitely warm spells, in latter March or early April. At that time they are readily found beneath boards and bark chips, there usually being two or three lizards beneath each bit of cover. Thereafter, the species is seen above ground only sporadically.

Carphophis amoena amoena.—In tiny tunnels beneath rocks, a foot or two beneath the surface.

Abastor erythrogrammus.—No winter records.

Farancia abacura abacura.—Leaves the water in late autumn and burrows deeply in the pulpy wood of decaying pine stumps on hills or banks overlooking the snake's summer habitat. Not dormant when disclosed.

Diadophis punctatus punctatus.—A gregarious hibernator; often as many as a dozen found together. Found in the soft pulp of decaying hardwood logs, beneath the bark, or in the tunnels of the beetle *Passalus cornutus;* also in insect burrows under thick moss on sunny slopes. Stiff and torpid when uncovered.

Heterodon contortrix contortrix.—The last reptile to go into hibernation. Young of the year, in particular, may be found foraging in November or December. Hibernates singly, beneath rocks, stumps, or rubbish piles, in burrows in hard red clay soil, or even beneath slabs of tin on the open ground. Semi-dormant when disclosed.

Heterodon simus.—No winter records.

Opheodrys aestivus.—No winter records for this very common snake. Its winter quarters are somewhat of a mystery.

Coluber constrictor constrictor.—Partial to tunnels left by the decay of pine roots. Prowls until late in autumn, and is one of the first snakes to appear in spring. In March, or on warm days in February, it emerges, often stained with the red clay subsoil, to bask in the sun. At such times it is readily captured.

Masticophis flagellum flagellum.—Forages well into the autumn, but does not emerge from hibernation until long after other species of snakes have become active. Usually in tunnels formed by the decay of pine roots on dry hillsides.

Elaphe guttata.—In rotting stumps, usually pine, on the higher ground bordering lakes and streams; occasionally in pine stumps in open fields or on barren red clay hillsides. The species has also adapted itself to city life, being astonishingly abundant in rat burrows and old water mains beneath the city of Augusta, Georgia. Often hibernates beneath the concrete floors of garages. Young of the year may turn up anywhere and at any time. Specimens overwintering in stumps move to the top of the stump on warm days, and lie beneath the bark on the sunny side. On cold days they retreat far below the surface along the tunnels formed by the decay of roots. The species is very active when disclosed, and must be grasped immediately to prevent its escape.

Elaphe obsoleta obsoleta.—Similar to *E. guttata,* but does not invade the more open fields or barren hillsides, and rarely occurs in the city.

Elaphe obsoleta confinis.—No winter records. A considerable percent of Richmond County rat snakes is intermediate between this form and the preceding; such examples do not differ from typical *obsoleta* in winter behavior.

Pituophis melanoleucus melanoleucus.—No winter records for this rare inhabitant of the rocky, northern portion of the county.

Pituophis melanoleucus mugitus.—Found throughout the year in burrows of the pocket gopher (*Geomys*).

Lampropeltis getulus getulus.—In rotting stumps on hillsides overlooking ponds and streams; comes to the top of the stump on warmer days; active when disclosed.

Lampropeltis triangulum elapsoides.—No winter records.

Cemophora coccinea.—Often dug out by road construction crews in wooded areas; also hibernates in rotting pine stumps.

Natrix erythrogaster erythrogaster.—No hibernation records for this rather common species.

Natrix septemvittata.—In November, 1936, I saw dozens upon dozens of snakes of this species, lying in the bushes bordering a short stretch of Spirit Creek, a Coastal Plain tributary of the Savannah River. The weather had been cool, and the snakes were quite lethargic. The species is moderately common in the rocky creeks of the Piedmont portion of the county, is very rarely met with in Spirit Creek and other streams of the Coastal Plain, and apparently does not range more than a few miles below the Fall Line in eastern Georgia. The aggregation was thus all the more remarkable; I believe it represented the entire queen-snake population of the creek. It is interesting to note that a similar pre-hibernation gathering has been reported for the species in Ohio (Wood, 1944; Copeia 4: 253). I have never uncovered a hibernating specimen.

Natrix sipedon fasciata.—Occasionally found beneath logs or rocks in swampy areas; young examples are sometimes found, nearly frozen, in such places. I believe the bulk of the population seeks safer retreats.

Natrix sipedon pleuralis.—Probably overwinters in cavities beneath the banks of ponds and streams, where they would not be encountered by collectors. The lack of hibernation records of *N. sipedon* is astonishing, considering the abundance and widespread distribution of the species.

Natrix taxispilota.—I believe that this snake overwinters in cavities or

burrows near the water's edge, since a rise of water level will bring out numbers of them regardless of the temperature. The reptiles, thus forced from their retreats, hang in bushes in the sunlight for several hours and then disappear, probably having been "thawed out" sufficiently to search for another shelter.

Storeria dekayi dekayi.—Hibernates gregariously, and often in company with *Diadophis p. punctatus,* in fallen logs or standing timber. Disclosed specimens flatten themselves remarkably, open the mouth, evert the cloaca, and writhe painfully, apparently in an effort to be frightening. Also common in the city of Augusta, beneath trash piles, about rock gardens, etc.

Storeria occipitomaculata occipitomaculata.—Overwinters singly or in pairs, usually under pine bark in densely wooded areas. Pine slabs about an old saw-mill site are favorite spots. Unable to crawl when uncovered, this species also tries intimidation by open-mouthed writhing. Many local specimens approach *S. o. obscura,* while others are intermediate.

Haldea striatula.—Beneath rocks in open fields or on red clay hillsides. Rather active when disclosed.

Haldea valeriae valeriae.—About logs, rubbish piles, dead grass, etc., usually in areas of moist soil.

Thamnophis sauritus sauritus.—No winter records for this fairly common snake.

Thamnophis sirtalis sirtalis.—A few specimens found beneath logs in flooded bottom-lands.

Tantilla coronata coronata.—In tunnels under large rocks, particularly on hillsides.

Micurus fulvius fulvius.—No winter records for this snake, only eight specimens having been collected since 1932.

Agkistrodon mokeson austrinus.—This species usually "dens." There is a large copperhead den on the northern outskirts of Augusta, in a rocky outcropping overlooking a small stream. This den borders a golf course; and each year many copperheads are killed by golfers in early spring. Not all the copperheads of the area frequent the den, however; I often find hibernating specimens beneath rotting stumps in the vicinity. In the Coastal Plain, copperheads commonly overwinter singly, beneath the bark of pine stumps on hillsides overlooking swamps. They are fairly active when disclosed.

Agkistrodon piscivorus piscivorus.—One of the last species to hibernate, being found abroad until the first heavy frosts. Then it leaves the water and seeks safety in a decaying pine stump on the higher ground bordering a lake or stream. Like the king, rat, and copperhead snakes, the cottonmouth comes to the top of its stump on warm winter days; but, unlike the others, it will also completely emerge to bask on the ground. It does not seem to be dormant at any time. The species almost invariably hibernates singly. I once found two examples beneath a rotten log, but have never seen any evidence of "denning."

Sistrurus miliarius miliarius.—On a mild day in February, 1937, I

noticed a *Sistrurus* emerging from a hole, probably a mammal burrow, about 50 feet back from a lake, in a small clearing. The snake coiled in the sunlight and remained several minutes. At my approach it rattled furiously but made no attempt to escape. This is my only winter record for this snake, which is rare here.

Crotalus horridus atricaudatus.—This species displays the most interesting behavior pattern in its hibernation. Each year there is a period of intensely hot, dry weather, usually in latter August, when the rattlers begin to prowl about. The snakes do not ramble aimlessly, but follow well-defined routes, usually in thick woods along a stream. Where such a route crosses a road, many rattlers are killed in August and September by the local residents, and the spot becomes known as "Rattlesnake Crossing." There are at least a dozen such "crossings" in southern Richmond and northern Burke Counties, Georgia. I once thought that the snakes were seeking cool swamps for relief from the heat; but careful inquiry of local residents, plus extensive personal observations, have revealed that, at each crossing, the snakes are always going in the same direction. When the directions and crossings are plotted on a map of the area, it becomes evident that the rattlesnakes, for a radius of at least 20 miles, converge each year upon an area of limestone caves in the Savannah River swamp. One trail, about 8 miles south of Augusta, led through pine forest at least a mile from water; and after the land was cleared and cultivated, the rattlers were not deterred—indeed, more are killed at a "crossing" on this trail than on any other spot in the area. Another trail once lay through pine scrub on the northwestern outskirts of Augusta; and the rattlers still use this trail, although it now runs through an area of suburban residences. Two or three snakes are killed in August or September on this trail each year, almost always in the same spot. Rattlesnakes are seen, year after year, swimming across certain lakes, always in the same places, in August or September. This suggests that damming of a stream and subsequent flooding do not alter the snakes' course. I am convinced that the extremely hot days of August provide the stimulus that starts the rattlesnakes on their way to the dens; and that they reach their winter retreats by the same well-defined paths, year after year. One can only guess as to what physiological or psychological factors are involved in this annual migration; I suspect an elaborate series of tropisms, such as those which lead turtle hatchlings from the nest to a lake (cf. Noble and Breslau, 1938; Jour. Comp. Psychol. 25: 175 *et seq.*). A goodly percentage of the snakes killed at "crossings" are gravid females, with young nearly ready for birth. Many of the young are probably born in or near the den. However, I have found a few young of the year on the trails in late summer, moving in the proper directions. I have encountered but one canebrake rattlesnake hibernating singly, and believe that denning is characteristic of the species.

Sternotherus minor.—No winter records for this turtle, which barely enters the southern tip of the county.

Sternotherus odoratus.—Beneath logs and trash in or near the water; in recesses beneath the banks of streams.

Sternotherus peltifer.—Several specimens of this form have been taken, but none in winter.

Kinosternon subrubrum subrubrum.—Similar to the preceding, but more frequently found beneath rotting logs and piles of debris some distance back from the water. Active when disclosed.

Chelydra serpentina serpentina.—Professional turtle hunters locate this species in hibernation by probing with an iron rod in the deeper holes of small streams. The turtles move about a bit during the winter, perhaps surfacing occasionally for a breath of air.

Clemmys guttata.—No winter records.

Terrapene carolina carolina.—Box turtles are very active in late autumn. Specimens are often noted nibbling fungi, males are observed fighting, and many pairs are seen *in copula.* With the advent of cool weather, the turtles begin to dig holes, usually in concealed spots, such as beneath a log or at the base of a rotting stump. Should the weather again turn warm, they abandon the excavations and commence foraging again. As a result of this reluctance to hibernate, many specimens are caught by sudden cold spells, and become too torpid to dig. They lie on the ground helplessly, and develop symptoms reminiscent of the common cold. Eventually they die, unless there comes another spell of favorable weather. Those turtles that do hibernate work themselves into the ground to a depth of several inches. In the early spring many emerge and are caught by sudden cold spells. Vast numbers of the reptiles freeze to death at this time, and the woods are littered with their shells. I believe that more box turtles are killed by cold than by all other factors together. The wholesale destruction may actually be of advantage to the species in eliminating weaker individuals, however; certainly the form is phenomenally abundant in this area. A friend and I once found 66 box turtles in a day on the northern outskirts of Augusta.

Chrysemys picta picta.—No winter records.

Pseudemys floridana concinna.—No winter records.

Pseudemys scripta scripta.—Overwinters in mud and aquatic vegetation about lake margins. On the first warm days of spring, these turtles seem very anxious to leave their winter retreats, and move overland directly away from the lake margins. Should the weather abruptly turn cold, as frequently happens, one can find many examples lying helpless in the woods, facing away from the lake and at varying distances from it. If low temperatures persist, many of the turtles die, thus accounting for the majority of empty shells found in woods near lakes.

Deirochelys reticularia.—Habits like the preceding. Often killed by cold spells in spring, but not as frequently as *Pseudemys.* Several other varieties of turtles are probably killed by sudden changes of temperature. Several writers have commented on the abundance of *Kinosternon* shells, for example; and have speculated as to what predators were responsible. Cold weather may well have been the destructive agency, however.

Amyda agassizii.—No winter records.

AUGUSTA JUNIOR COLLEGE, AUGUSTA, GEORGIA

Observations on the Eggs and Young of the Eastern Fox Snake

By ROBERT H. MATTLIN

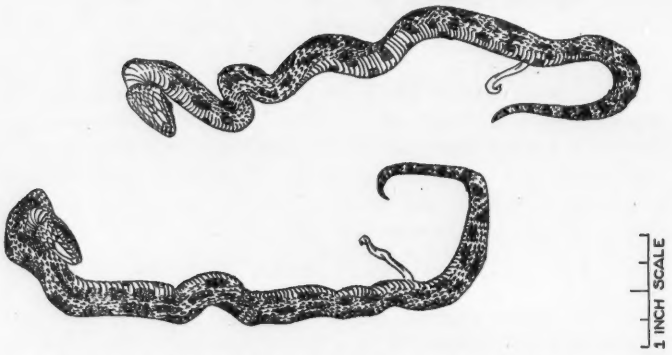
A large female Eastern Fox Snake, *Elaphe vulpina gloydi,* collected by Robert Harrison of Toledo, Ohio, at Little Cedar Point, Jerusalem Township, Lucas County, Ohio, July 1947, deposited twenty eggs on August 5, 1947. The clutch of eggs was not discovered until the morning of August 6, since the snake's cage was for some reason not examined on August 5, although it was ascertained no eggs were present late in the evening of August 4. The female weighed 472.6 gms and measured 1381 mm in total length after depositing her eggs.

The complement of eggs was in three adherent clusters of 9, 7, and 2 eggs each plus two single eggs. Ten of the group were noticeably shrunken and badly dented. No attempt was made to separate the eggs and the clusters and single eggs were not weighed since it was evident that those eggs which had the greatest surface exposed to the air had lost much moisture due to evaporation. The entire group was placed in dampened decomposed wood, in a one-gallon tin can with several holes punched in the lid. At no time was it necessary to sprinkle the eggs with water nor did the hatching media ever become too damp. The eggs were kept at ordinary room temperature and were examined frequently. The ten eggs which were in poor condition upon discovery shriveled to a shapeless mass within a few days while the remaining 10 retained their shape.

On September 18, at 8 A.M., 45 days after the eggs were deposited, the young snakes began to hatch. At this time two of the eggs displayed slits of approximately one quarter of an inch in length with the tips of the enclosed snakes' snouts protruding. At no time during the hatching of all of the specimens were egg teeth or any evidence of such noted. Another egg had split at 11 A.M. and at 5 P.M. the three mentioned snakes had their heads exposed. Upon being disturbed at this time, all three specimens withdrew their heads into the eggs.

At 8 A.M. on the morning of the 19th, two of the young had freed themselves of the eggs and the third was approximately half way out of the shell. The latter snake was completely hatched at 10:30 A.M. and two more specimens had their rostrums protruding from their respective eggs. By 1:30 P.M. the last mentioned two snakes had hatched and two more of the eggs had slight slits in evidence. The latter two eggs had hatched by the morning of the 20th. (It was noted here that an egg in the largest cluster had started to hatch but the young snake in trying to force its way between two other eggs had died in the attempt to free itself, its head being wedged tightly between the two offending eggs.)

The remaining two apparently good eggs had failed to hatch or show any evidence of doing so by September 22, and were opened to disclose two fully developed but badly deformed snakelets (see fig.).



The weight and total length of the living young were as follows:

	Length		*Weight*	
	306	mm	13.5	gms
	299	mm	11	gms
	284	mm	12.5	gms
	295	mm	12	gms
	303	mm	11.5	gms
	309	mm	13	gms
	264	mm	8.5	gms
Average	294.28	mm	11.71	gms

The extremes in length were 309 mm and 264 mm and in weight, 13.50 gms and 8.5 gms.

Without exception the baby snakes were ill-tempered, vibrating their tails rapidly and striking at the offending object repeatedly. Each strike was accompanied by the short hiss characteristic of many of the snakes of the genus Elaphe.

The illustration of the two deformed specimens is by Paul J. Schuster of the Cleveland Zoo staff.

CLEVELAND ZOOLOGICAL PARK, OHIO

Aneides from Oregon

By DR. WILLIAM A. HILTON

Aneides flavipunctatus

Locality. Mt. Hood region Oregon. In deep woods of State Forest, about 20 miles from Portland by the Mt. Hood highway.

Habitat. In deep fir forests under the bark of spruce logs.

Size. The larger specimen has a total length of 100 mm, of which the tail is 45 mm. Head length 15 mm. Tip of snout to gular fold 12 mm. A smaller example, total length 60 mm, tail 28 mm. Head length 12 mm. Tip of snout to gular fold 9 mm.

Description. Body slender, more so than related species of the same length. Head from above widest just back of the eyes, narrower a little further back. Parotid region moderately developed. Eyes quite large and prominent, iris black. From the eye back and down to the gular fold is a sunken wavy line. The head is moderately flat, especially between the eyes where it continues with a median depressed line which ends about one third of the way down the back. The trunk in cross section is slightly flattened above and below but is nearly cylindrical. The tail is nearly cylindrical in cross section at its base, but becomes slightly flattened towards the tip. There are 14 plainly marked costal grooves, but the last is double above. In a smaller specimen there were plainly 15 costal grooves. In the larger specimen there were 35 or more caudal grooves. In the smaller 24 or more. There were two to two and one half body segments between the toes of the appressed limbs. The legs are slender, the hind legs only slightly more heavy than the front appendages. In order of length from the shortest toes in the four front toes they are 1-(2-4)-3. In this 1 is small and 2 and 4 almost equal in length. In the hind foot the five toes are as follows: 1-(2-5)-3-4. One is very small and 2 and 5 almost of equal length. There is some webbing between the toes, especially on the hind feet. The anal opening is a straight slit without elevations. The tongue is broad, rather thick, free at the sides. It quite well fills the mouth. The vomerine teeth are in small slightly slanting patches with 4 to 5 teeth each. The parasphenoid teeth are in one patch which may be divided in front. The premaxillary teeth are quite large, four in number and quite widely spaced. The maxillaries each have two rather forwardly placed teeth. Each side of the mandible has four large teeth well to the front. The smallest is nearest the front. The last of the four is the largest. These teeth are especially large, slant back and are flat but sharp-pointed.

Color and *markings.* Above the head and body are a chocolate-brown flecked with small snowflake-like white spots which are smaller and more abundant on the upper head, but larger and less numerous along the sides and back. The tail at the sides is similarly colored and marked but in life its dorsal side from the body to the tip is marked with a bright red-

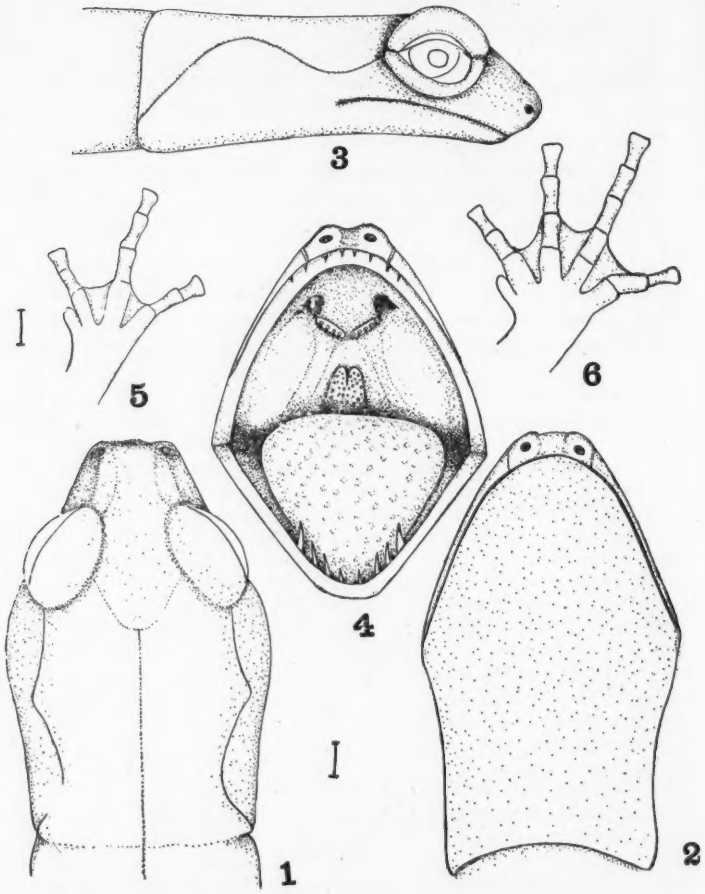


Figure 1. Scale equals 1 mm.
1. Head above. 2. Head below. 3. Head from the side. 4. Inside the mouth to show tongue, vomerine, palatine, premaxillary, maxillary and mandibular teeth. 5. Front foot, right. 6. Hind foot, right.

brown dorsal band which disappears in preservative. Below, the body, head and tail are a uniform dark gray with almost no flecks of white. The legs above are like the body with a few flecks of white. Below they are like other ventral parts with the under sides of the feet a little lighter.

Comparisons. This is most like *A. flavipunctatus,* but is more slender, less spotted than some and differently colored. A specimen of *A. flavipunctatus* from Humbolt Co., Calif., of 80 mm. had 8 premaxillary teeth, 3 maxillary on each side, vomers 5-4, the mandible on each side 6 of which 2 were large. Costal folds 14. It was dark above and below with more flecks of light below than the species described above.

A specimen from Rogue River region, Oregon, Curry Co., of 105 mm had 15 costal grooves. The premaxillary had 5-6 teeth, each maxillary 3-4, the vomers 3-4. Each side of the mandible 3 in front, 2 farther back. The body was dark above and below with flecks of light.

Another specimen from Del Norte Co., Calif., length 120 mm had 15 costal folds. The premaxillary had 6 small teeth, each maxilla 3. The vomers 3-3, each mandible a very large one. This specimen was dark, almost black above and below with many small yellowish flecks.

In an example of *A. ferreus* from Del Norte Co., Calif., of 125 mm length, the premaxilla had one large and 10 smaller teeth, the maxillae about the same and the vomerine patches 7 each. The mandible on each side had 10 large teeth. There were 16-17 costal grooves. The head, body and tail were dark above broadly and irregularly flecked with lighter areas. Below the specimen was light, yellowish mottled with lighter and darker areas.

In descriptions there is apparently some confusion in identifications of these two species, but it seems that *A. ferreus* usually has more costal folds, more teeth and is irregularly blotched above and perhaps below with the lower side in the living at least rather light, often yellowish. *A. flavipunctatus* has fewer costal folds, more teeth and is irregularly blotched above and perhaps below with the lower side in the living at least rather light, often yellowish. *A. flavipunctatus* has fewer costal folds, shorter legs, fewer teeth, its lower surface is dark, not light with flecks of white or yellow, smaller and not so numerous.

The specimens I have described from Mt. Hood region, Oregon, are most like *A. flavipunctatus,* but are clearly distinct in appearance. They are much more slender, the flecks of light are minute and mostly dorsal and the slender tail has a decided red brown color above. Other distinctive features would be in the regular arrangement of the few teeth. The large size of the mandibular teeth, the webbed toes and rather slender legs.

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Salamander Notes from the Northwest

By DR. WILLIAM A. HILTON

In April, 1947, a short trip was taken to the Northwest. The following are some of the notes on salamanders encountered:

Batrachoseps a. attenuatus, Walker's Pass, west. April 7.
Ten specimens 37 to 68 mm total length. This may be a new record for the eastern extension of this species. The specimens were all found in a slightly unusual situation for them; in a very wet place, in and out of the water of a spring.

Ensatina e. eschscholtzii, Lower Redwoods, April 8.
Two. Total lengths 103 and 106 mm.
N. west Washington, edge of the Olimpics, April 13.
One specimen, length 120 mm.

Ensatina e. picta, Del Norte Co., Calif., April 9.
8 pecimens 16 to 47 mm total length.

Plethodon vehiculum, North west Washington Apr. 13.
One specimen with a red-brown back in deep woods total length 70 mm. Another of about the same length a hundred miles farther north in a very wet place along with a number of *Rhyacotriton,* had a very red back. 5 specimens 66 to 84 mm. south shore of Crescent Lake, northern Olimpics. The backs of these varied in color from light red to brown, with now and then a slight tinge of green. They were all in dense woods.

Plethodon idahoensis from the type locality, Coeur d'Alene Lake, Idaho. April 18. 24 specimens from 30 to 120 mm total length. I have looked other places for this species without finding any, but from this restricted area of a few hundred feet I have now taken about forty in all.

Aneides flavipunctatus. Mt. Hood Highway, 20 miles from Portland. Two specimens 60 and 100 mm total length. It was very dry in Oregon at this time, Apr. 12, 1947. Only three salamanders were found.

Rhyacotriton olympicus. Crescent City (three miles south) Apr. 10. Nine larvae 37 to 63 mm total length. Five adults 71 to 78 mm. North West Olimpics, Washington, 7 adults 74 to 80 mm.

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